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Claims

[c0001] 1. A sensor pod (12′) comprising,

a processor (120) coupled with a memory (28′), said processor coupled to a first interface (72) and a second interface (74), and

a sensor (126) coupled to said processor and controlled thereby, wherein

said processor is designed and arranged to transmit first data to said first interface and receive second data at said second interface.

[c0002] 2. The sensor pod of claim 1 wherein

said processor is designed and arranged to simultaneously transmit first data to said first interface and receive second data at said second interface.

[c0003] 3. The sensor pod of claim 1 further comprising,

a communications converter (112) coupled between said first interface and said processor, wherein

said communications converter is designed and arranged to convert serial data at said first interface to a data format compatible with said processor and vice versa.

[c0004] 4. The sensor pod of claim 1 further comprising,

a communications converter (114) coupled between said second interface and said processor, wherein
said communications converter is designed and arranged to convert serial data at said second interface to a data format compatible with said processor and vice versa.

[c0005] 5. The sensor pod of claim 1 further comprising,
a sensor converter (124) coupled between said sensor and said processor, wherein
said sensor converted is designed and arranged to convert a signal generated by said sensor to data compatible with said processor.

[c0006] 6. The sensor pod of claim 1 further comprising,
a clamping mechanism (122) coupled to said processor and controlled thereby,
said mechanism being designed and arranged to releasably clamp said sensor pod to a borehole wall.

[c0007] 7. The sensor pod of claim 1 further comprising,
a switchable communications bypass (130, 132) coupled between said first interface and said second interface,
said switchable communications bypass controlled by said processor.

[c0008] 8. The sensor pod of claim 1 further comprising,
a direct current path (105) coupled between said first in-

terface and said second interface, said direct current path designed and arranged to block a.c. signal passage.

[c0009] 9. The sensor pod of claim 8 wherein,
said direct current path includes an inductive element (106).

[c0010] 10. The sensor pod of claim 7 wherein,
said switchable communications bypass is designed and arranged to block direct current.

[c0011] 11. The sensor pod of claim 10 wherein,
said switchable communications bypass includes a capacitive element (130).

[c0012] 12. The sensor pod of claim 1 further comprising,
a capacitive element (116) coupled between said first interface and said processor.

[c0013] 13. The sensor pod of claim 1 further comprising,
a capacitive element (118) coupled between said second interface and said processor.

[c0014] 14. The sensor pod of claim 1 further comprising,
a power supply (108) having an input (109) for coupling to a source of current and an output coupled to said processor,
said power supply designed and arranged to convert a

first voltage at said input to a second voltage compatible with said processor.

[c0015] 15. The sensor pod of claim 14 wherein,
said input of said power supply is coupled to said first interface (72).

[c0016] 16. The sensor pod of claim 1 wherein,
said first interface (72) is disposed at a first connector (42), said first connector being designed and arranged to be removably coupled to a first cable, and
said second interface (74) is disposed at a second connector (44), said second connector being designed and arranged to be removably coupled to a second cable.

[c0017] 17. The sensor pod of claim 1 wherein,
said first interface is coupled to a second interface of a like sensor pod.

[c0018] 18. The sensor pod of claim 1 wherein,
said first interface is coupled to a telemetry and control module (21′).

[c0019] 19. The sensor pod of claim 1 wherein,
said second interface is coupled to a first interface of a like sensor pod.

[c0020] 20. A sensor array (18′) comprising,

a telemetry and control module (21′), and
a plurality of sensor pods (12′) coupled to said telemetry and control module,
each of said plurality of sensor pods (12′) characterized by having a sensor (126) therein coupled to a memory (28′), having a first interface (72) coupled to said memory, having a second interface (74) coupled to said memory, and being designed and arranged to transfer first data from said memory to said first interface and second data from said second interface to said memory,
said telemetry and control module (21′) coupled to said first interface of a first of said plurality of sensor pods (12′) and
said second interface of said first of said plurality of sensor pods (12′) coupled to said first interface of a second of said plurality of sensor pods (12′).

[c0021] 21. The sensor array of claim 20 wherein
each of said plurality of sensor pods (12′) is designed and arranged to simultaneously transfer first data from said memory to said first interface and second data from said second interface to said memory.

[c0022] 22. The sensor array of claim 20 wherein,
first pod data is produced by said sensor of said first of said plurality and transferred to said memory of said first of said plurality,

second pod data is produced by said sensor of said second of said plurality and transferred to said memory of said second of said plurality,

said first pod data is transferred from said memory of said first of said plurality through said first interface of said first of said plurality to said telemetry and control module, and

said second pod data is transferred from said memory of said second of said plurality through said first interface of said second of said plurality and through said second interface of said first of said plurality to said memory of said first of said plurality.

[c0023] 23. The sensor array of claim 22 wherein,

said first pod data is transferred from said memory of said first of said plurality through said first interface of said first of said plurality to said telemetry and control module, and simultaneously

said second pod data is transferred from said memory of said second of said plurality through said first interface of said second of said plurality and through said second interface of said first of said plurality to said memory of said first of said plurality.

[c0024] 24. The sensor array of claim 22 wherein,

said second pod data is transferred from said memory of said first of said plurality through said first interface of

said first of said plurality to said telemetry and control module.

[c0025] 25. The sensor array of claim 20 wherein,

said plurality includes said first of said plurality, a last of said plurality and at least one inner of said plurality,

each of said at least one inner of said plurality has said first interface coupled to said second interface of a first adjacent of said plurality and said second interface coupled to a second adjacent of said plurality,

said first interface of said last of said plurality is coupled to said second interface of one of said at least one inner of said plurality, and

said first interface of said first of said plurality is coupled to said telemetry and control module and said second interface of said first of said plurality is coupled to said first interface of one of said at least one inner of said plurality.

[c0026] 26. The sensor array of claim 25 wherein,

last pod data is produced by said seismic sensor of said last of said plurality and transferred to said memory of said last of said plurality,

said last pod data is transferred from said memory of said last of said plurality to said telemetry and control module via each of said at least one inner of said plurality, being temporarily stored in said memory of each of

said at least one inner of said plurality, and via said first of said plurality, being temporarily stored in said memory of said first of said plurality.

[c0027] 27. The sensor array of claim 20 wherein each of said plurality is further characterized by,
a communications bypass (130) coupled between said first interface and said second interface,
said communications bypass having a switch element (132) having a first state which enables said bypass and a second state which disables said bypass.

[c0028] 28. The sensor array of claim 27 wherein each of said plurality is further characterized by,
said switch element (132) being controlled by said sensor pod (12′) in response to a signal received at said first interface (72).

[c0029] 29. The sensor array of claim 28 wherein,
said signal originates from said telemetry and control module (21′).

[c0030] 30. The sensor array of claim 28 further comprising,
a surface controller (20′) coupled to said telemetry and control module (21′), wherein
said signal originates from said surface controller.

[c0031] 31. The sensor array of claim 28 wherein,

said signal originates from said second interface (74) of an adjacent one of said plurality of sensor pods.

[c0032] 32. The sensor array of claim 29 wherein,
said switch elements (132) of each of said plurality are in said first state, and
each of said plurality of said pods nearly simultaneously receives said signal at said first interface from said telemetry and control module (21′).

[c0033] 33. The sensor array of claim 29 further comprising,
a surface controller (20′) coupled to said telemetry and control module (21′), wherein
said switch elements (132) of each of said plurality are in said first state, and
each of said plurality of said pods nearly simultaneously receives said signal at said first interface from said surface controller (20′).

[c0034] 34. The sensor array of claim 32 wherein,
said signal causes said sensors (126) of each of said plurality to measure data and transfer said data to corresponding said memories (28′) of each of said plurality.

[c0035] 35. The sensor array of claim 20 wherein,
communication between said plurality of sensor pods uses a communications protocol, and

communication between said telemetry and control module and said first of said plurality uses a communications protocol.

[c0036] 36. The sensor array of claim 35 wherein said communications protocol is a serial communications protocol.

[c0037] 37. The sensor array of claim 20 further comprising, a repeater (46) coupled between any two of said plurality of pods (12′), said repeater designed and arranged to increase the communications range between said two of said plurality.

[c0038] 38. The sensor array of claim 20 wherein each of said plurality further comprises,
a clamping mechanism (26′, 122) designed and arranged to releasably clamp said sensor pod to a borehole wall.

[c0039] 39. The sensor array of claim 38 wherein each of said plurality is further characterized by,
said clamping mechanism (26′, 122) being controlled by said sensor pod in response to a signal received at said first interface (72).

[c0040] 40. The sensor array of claim 39 wherein,
said signal originates from said telemetry and control module (21′).

[c0041] 41. The sensor array of claim 39 further comprising,
a surface controller (20′) coupled to said telemetry and control module (21′), wherein
said signal originates from said surface controller.

[c0042] 42. The sensor array of claim 39 wherein,
said signal originates from said second interface (74) of an adjacent one of said plurality of sensor pods (12′).

[c0043] 43. The sensor array of claim 20 wherein each of said plurality further comprises,
a processor (120) coupled to said memory (28′), said first interface (72) and said second interface (74), said processor designed and arranged to interpret signals received at said first interface and control said sensor pod.

[c0044] 44. The sensor array of claim 20 wherein,
said sensor is a seismic sensor.

[c0045] 45. The sensor array of claim 20 further comprising,
a plurality of cables (24′), wherein
each of said plurality of sensor pods (12′) has upper and lower ends and characterized by being designed and arranged to be repeatably coupled and uncoupled to a first and second of said plurality of cables at both said upper and lower ends, and
said plurality of sensor pods are removably coupled to-

gether upper end to lower end by said plurality of cables to form a string, with a first end of said string of sensor pods removably coupled to said telemetry and control module with one of said plurality of cables.

[c0046] 46. The sensor array of claim 45 wherein each of said plurality of sensor pods is characterized by,
having a processor (120) designed and arranged to communicate with said telemetry and control module and with other sensor pods and designed to store an identification.

[c0047] 47. The sensor array of claim 46 wherein,
said telemetry and control module can query each of said plurality of sensor pods, and
each of said plurality of sensor pods is designed and arranged to answer a query.

[c0048] 48. The sensor array of claim 47 wherein,
said telemetry and control module harmonizes with said plurality of sensor pods to establish a unique identification for each of said plurality of sensor pods, and,
said telemetry and control module (21′) registers the position in said string of each of said sensor pods relative to the plurality of sensor pods.

[c0049] 49. The sensor array of claim 47 wherein,

using a particular identification, said telemetry and control module queries a specific one of said plurality of sensor pods, and
said specific one of said plurality of sensor pods answers said telemetry and control module.

[c0050] 50. The sensor array of claim 49 wherein,
said telemetry and control module queries about a status of a sensor (126).

[c0051] 51. The sensor array of claim 49 wherein,
said telemetry and control module queries about a status of a memory (28′).

[c0052] 52. The sensor array of claim 49 wherein,
said telemetry and control module queries about a voltage level.

[c0053] 53. The sensor array of claim 49 wherein,
said telemetry and control module queries about a status of a clamping mechanism (26′, 122).

[c0054] 54. The sensor array of claim 47 wherein,
using a particular identification, said telemetry and control module commands a function of a specific one of said plurality of sensor pods, and
said specific one of said plurality of sensor pods performs said function.

[c0055] 55. The sensor array of claim 54 wherein,
said telemetry and control module commands to manipulate a clamping mechanism (26′, 122).

[c0056] 56. The sensor array of claim 54 wherein,
said telemetry and control module commands to manipulate a switch element (132).

[c0057] 57. The sensor array of claim 54 wherein,
said telemetry and control module commands to control a sensor (126).

[c0058] 58. The sensor array of claim 47 wherein,
said telemetry and control module simultaneously commands each of said plurality of sensor pods to record data.

[c0059] 59. The sensor array of claim 47 wherein,
said telemetry and control module nearly simultaneously commands each of said plurality of sensor pods to transmit data.

[c0060] 60. The sensor array of claim 45 further comprising,
a main controller (20′) coupled to said telemetry and control module (21′).

[c0061] 61. The sensor array of claim 60 wherein each of said plurality of sensor pods is characterized by,

having a processor (120) designed and arranged to communicate with said main controller and with other sensor pods and to store an identification.

[c0062] 62. The sensor array of claim 61 wherein,
said main controller is designed and arranged to query each of said plurality of sensor pods, and
each of said plurality of sensor pods is designed and arranged to answer a query.

[c0063] 63. The sensor array of claim 62 wherein,
said main controller is designed and arranged to harmonize with said plurality of sensor pods to establish a unique identification for each of said plurality of sensor pods, and
said main controller (20′) is designed and arranged to register the position in said string of each of said sensor pods relative to the plurality of sensor pods.

[c0064] 64. The sensor array of claim 62 wherein,
using a particular identification, said main controller is designed and arranged to query a specific one of said plurality of sensor pods, and
said specific one of said plurality of sensor pods is designed and arranged to answer said main controller.

[c0065] 65. The sensor array of claim 64 wherein,

said main controller is designed and arranged to query about a status of a sensor (126).

[c0066] 66. The sensor array of claim 64 wherein,
said main controller is designed and arranged to query about a status of a memory (28′).

[c0067] 67. The sensor array of claim 64 wherein,
said main controller is designed and arranged to query about a voltage level.

[c0068] 68. The sensor array of claim 64 wherein,
said main controller is designed and arranged to query about a status of a clamping mechanism (26′, 122).

[c0069] 69. The sensor array of claim 62 wherein,
using a particular identification, said main controller is designed and arranged to command a function of a specific one of said plurality of sensor pods, and
said specific one of said plurality of sensor pods is designed and arranged to perform said function upon said command.

[c0070] 70. The sensor array of claim 69 wherein,
said main controller is designed and arranged to command a specific one of said plurality of sensor pods to manipulate a clamping mechanism (26′, 122).

[c0071] 71. The sensor array of claim 69 wherein,
said main controller is designed and arranged to command a specific one of said plurality of sensor pods to manipulate a switch element (132).

[c0072] 72. The sensor array of claim 69 wherein,
said main controller is designed and arranged to command a specific one of said plurality of sensor pods to control a sensor (126).

[c0073] 73. The sensor array of claim 62 wherein,
said main controller is designed and arranged to simultaneously command each of said plurality of sensor pods to record data.

[c0074] 74. The sensor array of claim 62 wherein,
said main controller nearly simultaneously commands each of said plurality of sensor pods to transmit data.

[c0075] 75. A method for conducting a downhole survey comprising the steps of,
assembling a string (18′) of intelligent sensor pods (12′) containing sensors (126) and memory (28′),
connecting one end of said string to a telemetry and control module (21′),
lowering said string into a borehole (14),
collecting data with said sensors,

storing said data in said memory, and

transmitting said data from said memory to said telemetry and control module in a bucket brigade transfer, wherein a bucket brigade transfer comprises the steps of,

each sensor pod transmitting data stored in said memory upwards, and

each sensor pod receiving data, if any, from a sensor pod coupled below it, if any, and storing said received data in said memory.

[c0076] 76. The method according to claim 75 wherein,

said survey is a seismic survey, and

said data are seismic data.

[c0077] 77. The method of claim 75 wherein,

said transmitting and receiving of data occurs simultaneously.

[c0078] 78. The method of claim 75 wherein,

said transmitting and receiving of data occurs sequentially.

[c0079] 79. The method of claim 75 further comprising the steps of,

arming each sensor pod within said string to receive a simultaneous trigger signal by enabling a direct commu-

nications path (132, 130) along a common conductor (24′, 72) to each sensor pod within said string.

[c0080] 80. The method of claim 79 further comprising the step of,

powering said string (18′) of intelligent sensor pods (12′) via said common conductor (24′, 72).

[c0081] 81. The method of claim 79 further comprising the step of,

after arming each sensor pod, simultaneously triggering each sensor pod within said string to begin recording data.

[c0082] 82. The method of claim 81 wherein,

said triggering is caused by a signal transmitted by said telemetry and control module (21′) along said common conductor.

[c0083] 83. The method of claim 81 wherein,

a surface controller (20′) is coupled to said telemetry and control module, and

said triggering is caused by a signal originating from said surface controller.

[c0084] 84. The method of claim 79 further comprising the steps of,

simultaneously triggering each sensor pod to begin said

bucket brigade transfer, and

after said triggering, disabling said direct communications path (130, 132), forcing communication along said string to flow through said memory (28′) of said sensor pods.

[c0085] 85. The method of claim 84 wherein,

said triggering is caused by a signal transmitted by said telemetry and control module (21′) along said common conductor.

[c0086] 86. The method of claim 84 wherein,

a surface controller (20′) is coupled to said telemetry and control module, and

said triggering is caused by a signal originating from said surface controller.

[c0087] 87. The method of claim 75 further comprising the steps of,

choosing a desired number of sensor pods based on requirements of said survey,

choosing a combination of said sensor pods to have a desired combination of sensor types based on requirements of said survey,

choosing cables (24′) with desired lengths to couple said string (18′) of sensor pods (12′) together and to couple said string to said telemetry and control module based

on requirements of said survey, and

assembling said intelligent sensor pods in the field using said chosen sensor pods and said chosen cables.

[c0088] 88. The method of claim 75 further comprising the steps of,

in the field, repairing said string (18′) of sensor pods (12′) by disconnecting a faulty sensor pod and connecting a replacement sensor pod in its place.

[c0089] 89. The method of claim 75 further comprising the steps of,

in the field, repairing said string (18′) of sensor pods (12′) by disconnecting a faulty cable (24′) and connecting a replacement cable in its place.

[c0090] 90. The method of claim 75 further comprising the step of,

after said step of transmitting said data, raising said string (18′) from said borehole (14),

disconnecting said telemetry and control module (21′) from said string, and

disassembling said string.

[c0091] 91. The method of claim 75 further comprising the step of,

automatically determining the composition and charac-

teristics of said string (18′) by querying said intelligent sensor pods (12′).

[c0092] 92. The method of claim 75 further comprising the step of,

selectively clamping said sensor pods (12′) to a wall of said borehole (14),

selectively unclamping said sensor pods from said wall, and

controlling said selective clamping and selective unclamping with said telemetry and control module (20′).

[c0093] 93. The method of claim 75 further comprising the step of,

selectively clamping said sensor pods (12′) to a wall of said borehole (14),

selectively unclamping said sensor pods from said wall, and

controlling said selective clamping and selective unclamping with a surface controller (21′) coupled to said telemetry and control module.

[c0094] 94. The method of claim 75 further comprising the step of,

extending a communications range between two adjacent of said sensor pods (12′) by coupling a repeater (46) therebetween.

[c0095] 95. A method for transferring data stored in a plurality of serially interconnected sensor pods, each of said pods characterized by having a memory for storing said data, to a telemetry and control module coupled thereto comprising the steps of,

transferring first data stored in said memory of a first pos of said plurality of serially interconnected sensor pods to said memory of a second pod of said plurality of serially interconnected sensor pods, and

then transferring said first data stored in said memory of said second pod to said telemetry and control module.